DOCUMENT RESUME

ED 351 184 SE 052 374

AUTHOR Heppner, Frank; And Others
TITLE American College Biology and Zoology Course Requirements: A de facto Standardized Curriculum.
INSTITUTION Rhode Island Univ., Kingston.
SPONS AGENCY Fund for the Improvement of Postsecondary Education (ED), Washington, DC.
PUB DATE 89
NOTE 47p.; Edited version published in the Journal "BioScience" (v40 n2 p130-134 Feb 1990).
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Biology; Curriculum Design; *Curriculum Development; Higher Education; Science Curriculum; *Science Education; Science Instruction; *Zoology

ABSTRACT

Without a formal mechanism to produce consensus, American colleges generally have come to agree on what constitutes an appropriate set of course requirements for Biology and Zoology majors. This report describes a survey of American four-year colleges and universities offering biology and/or zoology degrees. Questionnaires were sent to 741 biology and zoology departments asking for the current course requirements for majors, and for novel or innovative curricular features. Replies were received from 270 departments. From the results, very few unusual curricula in biology were detected. A majority of colleges (70.3%) require at least a semester of introductory biology, genetics, ecology, physiology, and cell biology. An even greater majority of colleges (79.3%) require at least a semester of chemistry and physics, and organic chemistry. There are far more similarities than differences in the course requirements of the departments. The only surprise was that smaller, lower ranked colleges are more likely to have a research and undergraduate seminar requirement than research-oriented colleges. (PR)

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American College Biology and Zoology Course Requirements

A de facto Standardized Curriculum

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and William Krueger

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American College Biology and Zoology Course Requirements

Abstract

270 American Biology and Zoology departments were surveyed for their course and credit requirements for undergraduate degrees. Although there were some differences, primarily in physical science requirements, between different categories of schools, Biology requirements were generally similar.

The objective of this project was to develop a rational, data-based process for generating a college biology curriculum, then test the process in the Department of Zoology at the University of Rhode Island. Possibly due to a unique circumstance at this University, internal political, emotional, and "turf" questions played a far more important role in shaping curriculum than did "rational" processes. In the course of generating data for the "rational" arguments, however, we conducted a survey of American college biology departments, and discovered that there is, for all pratical purposes, a "Standardized" college biology curriculum. The results of this sub-study will be published separately.

An edited version of this paper has been published in the Journal "BioScience" (v40 n2 p130-134 Feb 1990).

SE

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Grant No:	G008730471-88
Project Dates:	Starting Date: September 1, 1987 Ending Date: August 31, 1989 Number of Months: 24
Project Director:	Frank Heppner Department of Zoology University of Rhode Island Kingston, RI 02881 Telephone: (401) 792-2372
FIPSE Program Officer:	Sandra Newkirk
Grant Award:	Year 1 40,112 Year 2 11,086 Total $51,198

American College Biology and Zoology Course Requirements

A *de facto* Standardized Curriculum

Frank Heppner, Carl Hammen, G. Kass-Simon
and William Krueger

Without a formal mechanism to produce consensus, American colleges generally have come to agree on what constitutes an appropriate set of course requirements for Biology and Zoology majors. During 1988, as part of a larger study on the process of biology curriculum development sponsored by the Fund for Improvement of Post-secondary Instruction (FIPSE), we conducted a survey of the course requirements of American four year colleges and universities offering either a Biology or Zoology degree. Of the 1,846 biological and agricultural departments listed in the Directory of Bioscience Departments in the United States and Canada (AIBS, 1967), we identified 600 self-proclaimed Biology departments, and 141 Zoology departments. We wrote to the chairpersons of each of these departments, asking for the current course requirements for their majors, and asking them to identify any novel, unusual, or innovative curricular features.

By our cut-off date, three months after the initial letter, we received 270 replies, or 38% of the total, of which 240 colleges offered the Biology degree. Subsequent to the cutoff, we received 31 additional replies, but they were not sufficiently different to alter our conclusions, and were therefore not included.

Several of the larger colleges offer "tracks" within a common degree title such as Biology. These tracks, for example

organismal biology, or molecular biology, carry their own degree requirements, but for our analysis, we included only those courses required in common for all tracks.

Responding colleges were placed in three categories: American Association of University Professors (AAUP) class, number of full-time undergraduate students, and Gourman rating (Gourman, 1985). AAUP Class I colleges offer the doctorate, Class IIA schools have a substantial graduate program but do not offer the doctorate, Class IIB colleges have few or no graduate programs, and Class III colleges are community or proprietary two-year colleges.

The Gourman rating is a commercially available numerical ranking of undergraduate colleges and college departments, based on such factors as library size, fraction of faculty with doctorates, research funding, etc. Not surprisingly, "famous" colleges tend to have high ratings, and small regional schools have lower ratings. Gourman departmental ratings are not available for all colleges, so we used the Gourman college rating for our analysis. For those schools which did have Biology or Zoology department ratings available, there was generally close correspondence between college and department rating. Table 1 lists the sample distribution by AAUP class, Table 2 by enrollment, and Table 3 by Gourman rating.

The fraction of all schools requiring specific types of courses for their degrees is shown in Tables 4 and 5. Where it was not immediately obvious from the course's title what kind of course it was, the college's catalog was consulted to determine

where within our categorization scheme the course fit. There were two fairly common either/or requirements; comparative anatomy or development, and vertebrate or invertebrate zoology. We were unable to distinguish between Biology and Zoology degrees in terms of course requirements. There were no identifiable differences between Biology and Zoology degrees in requirements for Introductory Botany, Botany beyond 1 semester, and Microbiology, the three areas where differences might be expected.

The distribution of course requirements for colleges requiring specific courses arranged by Gourman rating, where there was an identifiable difference between colleges of different rating is shown in Table 6. Higher ranked colleges tended to be more likely than lower ranked colleges to require a semester of Molecular Biology, a year of Physics, Calculus or Statistics. Highest ranked schools tended to be more likely to require Development or a combination Development-Comparative Anatomy course than other schools. Lower ranked schools tended to be more likely to require a semester of introductory Zoology, Microbiology, Research, an undergraduate Seminar, or Algebra. There were no appreciable differences between schools of different rankings in those few schools requiring Botany, Microbiology or Botany beyond one semester, between schools offering Biology rather than Zoology degrees.

The distribution of colleges requiring specific courses arranged by size, where there was an apparent difference between colleges of different sizes is shown in Table 7. Of the few

colleges which require Molecular Biology, the largest are most likely to have this requirement. Smaller colleges were more likely to require an undergraduate Seminar, undergraduate Research, and a semester each of Biology and Zoology. Medium sized colleges were more likely to require Microbiology, some kind of Animal Diversity course or Statistics.

The distribution of course requirements for colleges requiring specific courses, arranged by AAUP class, where there was apparent difference between colleges of different AAUP classes is shown in Table 8. Class IIA and IIB colleges were more likely than Class I colleges to require a semester of introductory Zoology, a semester of introductory Botany, Vertebrate Zoology, and an undergraduate Seminar. Class IIB colleges were more likely than Class I or IIA colleges to require undergraduate Research. Class I colleges were more likely than class IIA or IIB colleges to require a semester of Development.

The number of biology, chemistry, physics, and math credits required for the degree, plus the number of specified biology courses required for either BS or BA biology degrees, for colleges on both the quarter and semester academic year are shown in Table 9. Colleges which had no specified number of credits or courses in a particular category (math, physics, etc.) were not included. For semester colleges, assuming each course is 3-4 credits, these values represent requirements for approximately 9-12 biology courses, of which 4-5 are specified, four courses in chemistry, two in math, and two in physics. Although extremes are not uncommon (a few schools on the quarter system specify

more than 60 credits in biology), 49% of all semester colleges require between 30 and 38 biology credits.

The number of biology, chemistry, physics, and math credits for semester and quarter year colleges, arranged by AAUP class, size, rating, degree, and degree type and shown in Tables 10 and 11. All colleges reporting were included here, whether they had specific numerical credit requirements or not. Most colleges had a defined number of biology credits, which varied slightly between subcategories (higher ranked colleges tended to require fewer credits than lower ranked colleges, BA degrees required more credits than BS degrees, and AAUP class I colleges required slightly fewer credits than classes IIA and IIB, but the requirement pattern differed sharply in the physical sciences and mathematics.

For example, within AAUP classes, class IIB colleges require considerably fewer average credits in physical sciences and mathematics than do the other two classes. However, as Table 12 suggests, the lower average number of credits for IIB colleges was primarily due to the lower number of class IIB colleges which had <u>any</u> physical science or math requirements. If only those schools having physical science or mathematics requirements are included, the average number of credits is similar across the classes.

"Unusual" Curricula

We were able to identify very few "unusual" curricula in college biology. In 1967, there were about two dozen colleges

that had some atypical curricular features (AIBS, 1967), for example, individualized curricula based on negotiation between student and advisor, or departmental examinations for graduation, but by 1988, their numbers had dwindled to less than a dozen, primarily very small, "experimental" colleges. Some schools had required all their students to pass the Graduate Record Examination in biology at a certain level, but had abandoned this requirement when it was found that the student's cumulative grade point average in major courses provided essentially the same information, as we discovered when we contacted the present department chairs. A few colleges required summer attendance at a field research station, usually one operated by the college.

Some of the conservatism in course requirements is probably due to the fact that Biology departments are the traditional jumping-off points for professional schools in medicine and veterinary medicine, and the real and perceived course requirements for entrance to these schools (or good performance on examinations such as the Medical College Admission test) limit the possible number of genuinely different curricular offerings.

The American "Standard" Biology Curriculum

A majority of colleges (70.3%) require at least a semester of introductory Biology, Genetics, Ecology, Physiology, and Cell Biology. Other biology courses were less often mandatory, but an even greater majority (79.3%) of colleges required at least a semester of chemistry and physics, and organic chemistry.

There are far more similarities than differences between course requirements in American colleges, despite the lack of a formal national mechanism for determining curricula. Perhaps the only real surprise is the finding that smaller, lower ranked colleges are much more likely to have a research and undergraduate seminar requirement than research-oriented colleges themselves, possibly because these courses are very faculty-labor intensive. Biology course and credit requirements are remarkably similar, but physical science and math requirements tend to be less at smaller, lower ranked institutions.

As a result of this study we would like to suggest that perhaps "quality" in curriculum is more a matter of what is taught in the courses, rather than what courses are required for graduation.

Data Base Availability

The data complied for this study might have utility for institutions contemplating curricular change. Copies are available for one year from the time of publication of this paper for $7.50, payable to the University of Rhode Island, to cover the disc and mailing. The data base requires Lotus and dbase III knowledge to use, and is only available on IBM 5 1/4" discs. Correspondence should be addressed to the senior author.

Acknowledgments

We would like to thank first, the hundreds of department Chairs who responded to our inquiry, often with detailed personal

letters. Sandy Newkirk of the FIPSE office in Washington was extraordinarily helpful in making the bureaucratic end of things relatively painless. Sudip Chackraborty, Govindraj Kamath, and Elaine Palm set up and massaged the data base. This study was supported by FIPSE grant G008730471-88.

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AIBS, 1967. Directory of bioscience departments in the United States and Canada. Compiled by J.D. Lockard. Reinhold Pub., N.Y.

Gourman, J. 1985. The Gourman report: a rating of undergraduate programs in American and International Universities. 5th ed. National Educational Standard Pub., Los Angeles.

Synopsis of Dr. Robert Diamond's Remarks at Curriculum Workshop

4 December 1987

The following represents a condensation of the points raised by Dr. Diamond at the workshop:

Model Curricular Process

Reasons for embarking on curricular change. - Institutions are prompted by a variety of forces; generalized feeling of need for change, employer feedback, feedback from alumni, changes in the field itself. Several examples were presented where graduates were contacted after they took employment in the field, and it was discovered that needed skills were not covered in an existing curriculum--thus it is important to keep in touch with alumni to see if the curriculum still is serving needs.

The first, and possibly most important step in curriculum revision is to insure that all of the key factions in the unit are represented on the body formulating the curriculum. Unless there is a general feeling of "ownership" in the new curriculum, it is likely to be blocked, or heavily modified by the "out" group, when the final decision process begins.

It is critical to establish early contact with agents which can block the curriculum, e.g., other departments, registrar, deans, etc. If they can feel part of the process, rather than being handed a final product for yea or nay, they are less likely to say nay.

It is usually best to start from scratch, rather than try to analyze deficiencies in an existing curriculum.

To help determine what the needs are of graduates, it is very helpful to form an advisory panel of employers, professionals, representatives of professional schools where appropriate, etc. In addition to providing valuable input, this body can provide contacts for graduates.

Gathering data from recent graduates is critical. Once they are in their profession, what skills and competencies do they need? What factors materially contribute to success in the field?

It is also important to gather data about current students. What are their competencies upon entrance? What specific skills are required for each course?

Very important to know who the students are--what do they do after graduation? Do most of them go to professional schools? If so, what kind? Do they go directly into the job market? Do any students in the major elect it for non-vocational reasons? If so, why did they elect the major? What are the characteristics of major students? Do they have a lot of remedial problems? Are they generally above average in scholastic ability?

The institutional mission should be considered in curriculum design, e.g., small, select liberal arts college may have different mission than large, open admission land grant school. Department curriculum should be compatable with mission or larger units (college, division, etc.).

The curriculum should not force students to make a commitment to a major too early, especially if students have a choice between similar majors. Students should have an introduction to the whole field very early--especially important for students not fully committed to the major.

Departments which will be impacted by curriculum changes should be involved at a very early stage, to avoid feelings of "take it or leave it".

Important at the start to be thinking, "what is desirable", rather than "what is possible". The latter question must ultimately be addressed, but the liklihood of getting what is desirable is increased if the former is the starting point.

Genuinely different changes, e.g., flexible credit courses, flexible duration courses, "Chinese menu" courses, can offer many advantages. Registrar is key person in these kinds of changes.

A problem which must be addressed is conflict of needs between majors taking courses, and non-majors who must take the same course as a pre-requisite for their own courses, e.g., math and chemistry for bio majors. Tracking within the course, and separate courses are possible solutions.

EVALUATION

Goals and objectives for a curriculum must be stated in terms that can be somehow measured, if the curriculum is to be evaluated. For example, if a goal is that the student learn to think and solve problems, how, specifically, does the student demonstrate that he can think?

To properly evaluate a curriculum, data should be gathered on students both before and after the curriculum is put in place.

AAUP Classes	Number in each Class	% of Total in Classes	Average Size	Average Rating
Unknown	17	6.3	-	-
I	61	22.6	12814	4.18
IIA	101	37.4	5594	3.24
IIB	89	33.0	1671	2.91
III	2	0.7	-	-
Total	270	100.0		

Table 1. Distribution of responding schools by AAUP class.

Size	# Records in Size Class	% of Total in Classes	Average Size	Average Rating	Percentage in AAUP Class I	IIA	IIB
Unknown Size	6	2.2	-	-			
> 20000	13	4.8	26176	4.3	61.5	15.4	0.0
> 15000 < 20000	11	4.1	16713	3.9	90.9	9.1	0.0
> 10000 < 15000	36	13.3	12655	3.8	61.1	30.6	0.0
> 5000 < 10000	49	18.2	6786	3.5	24.5	67.4	6.1
> 3000 < 5000	43	15.9	3807	3.2	11.6	62.8	16.3
> 2000 < 3000	24	8.9	2513	3.3	12.5	33.3	50.0
> 1000 < 2000	58	21.5	1468	2.8	0.0	27.6	70.7
< 1000	30	11.1	687	2.84	0.0	6.7	83.3
	270	100.0					

Table 2. Distribution of responding schools by size.

Rating Class	# Records in Rating Class	% of Total in Class	Average Size	Average Rating	Percentage in AAUP Class I	IIA	IIB
> 4.5	26	9.6	16310	4.70	92.3	3.9	0.0
> 4.0 < 4.5	21	7.8	9184	4.16	76.2	9.5	14.3
> 3.5 < 4.0	38	14.1	8307	3.78	34.2	47.4	7.9
> 3.15 < 3.5	51	18.9	6553	3.29	5.9	78.4	13.7
> 3.0 < 3.15	50	18.5	4094	3.07	8.0	44.0	48.0
> 2.5 < 3.0	70	25.9	1914	2.80	0.0	22.9	68.6
< 2.5 > 0	4	1.5	2956	2.46	25.0	25.0	50.0
Unknown	10	3.7	2471	0	0.0	10.0	20.0
	270	100.0					

Table 3. Distribution of responding schools by Gourman rating.

1st Year	%	2nd Year	%
1 Sem/Qrt Biology	20.4	Ecology	47.8
1 Year Biology	48.9	Genetics	75.2
1 Sem/Qrt Zoology	28.2	Physiology	38.5
1 Sem/Qrt Botany	28.9	Comp Anat	13.7
At least 1 Sem/Qrt		Development	13.3
Intro Course	97.4	Comp Anat/Develop	24.1

Table 4. Percentage of all schools requiring specific 1st and 2nd year courses (n=270).

Upper Division	%	Corollary	%
Evolution	18.2	1 Year Chemistry	77.7
Vertebrate Zoology	5.9	Organic Chemistry	72.6
Invertebrate Zoology	8.2	Biochemistry	5.6
Molecular Biology	10.7	1 Year Physics	57.4
Animal Diversity	4.4	Algebra	6.7
Microbiology	20.7	Calculus	57.7
Research	7.8	Statistics	15.6
Seminar	32.6	Computer Science	6.3
Botany beyond 1 Sem/Qrt	7.4		
Vert Zoo/Invert/Diversity	15.2		
Cell Biology	40.4		

Table 5. Percentage of all schools requiring specific upper division biology, physical science, and math courses (n=270).

Rating	No. in Class	Intro Zool	Dev	Micro-Bio	Mol Bio	Re-search	Seminar	Algebra	Calculus	Statistics	Yr Physics
> 4.5	26	0	11	1	7	0	1	0	23	10	20
> 4.0 < 4.5	21	2	2	4	1	0	6	1	17	4	16
> 3.5 < 4.0	38	6	2	5	7	0	6	2	26	7	28
> 3.2 < 3.5	51	19	5	11	7	0	11	3	27	9	30
> 3.0 < 3.2	50	15	6	9	4	5	18	4	21	3	19
> 2.5 < 3.0	70	29	8	23	2	13	37	7	37	7	37
< 2.5 > 0	4	1	1	1	1	1	3	0	2	1	2
Unknown	10	4	1	2	0	2	6	1	3	1	3
Total	270	76	36	56	29	21	88	18	156	42	155
% of Total		28.2	13.3	20.7	10.7	7.8	32.6	6.7	57.8	15.6	57.4

Table 6. Number of schools requiring specific courses arranged by Gourman rating. Courses not listed did not suggest differences between schools of different rating.

Size	No. in Class	Int. Bio & Intro Zoo	Mol Bio	Research	Sem-inar	Micro Bio	Diversity/ V Zoo/Inv Zoo	Stats
Unknown Size	6							
Size >= 20K	13	0	3	0	1	1	4	2
Size >= 15K < 20K	11	1	0	0	0	6	6	2
Size >= 10K < 15K	36	5	4	0	5	4	5	12
Size> = 5K < 10K	49	2	8	1	10	8	2	10
Size >= 3K < 5K	43	4	6	1	18	8	4	7
Size >= 2K < 3K	24	0	3	1	8	3	4	2
Size > = 1K < 2K	58	7	3	14	30	17	11	3
Size < 1K	30	9	2	4	13	10	5	4
Total	270	25	29	21	85	57	41	42
% of Total		10.4	10.7	7.8	31.5	21.1	15.2	15.6

Table 7. Number of schools requiring specific courses arranged by size. Courses not listed did suggest differences between schools of different size.

AAUP Class	No. in Class	Intro Zool	Intro Bot	Dev	Vert Zoo	Re-search	Sem-inar
Unknown	17	7	7	3	2	2	10
I	61	6	7	13	1	1	6
IIA	101	30	32	11	8	3	29
IIB	89	32	33	9	5	15	43
III	2	1	0	0	0	0	0
Total	270	76	79	36	16	21	88
% of Total		28.2	29.3	13.3	5.9	7.8	32.6

Table 8. Number of schools requiring specific courses arranged by size. Courses not listed did not suggest differences between schools of different AAUP classes.

	Biology Credits	Chem Credits	Physics Credits	Math Credits	BA Biology Courses	BS Biology Courses
Quarter n = 43	46.5 ± 12.7 (40)	22.5 ± 5.7 (30)	11.7 ± 2.3 (28)	9.6 ± 4.9 (29)	5.6 ± 3.7 (16)	6.7 ± 3.2 (23)
Semester n = 227	36.3 ± 6.0 (221)	16.2 ± 4.9 (132)	8.1 ± 1.9 (105)	6.7 ± 2.7 (111)	5.4 ± 2.1 (109)	4.2 ± 3.2 (205)

Values are $\bar{x} \pm$ S.D. Number in parentheses is number of schools having a requirement greater than 0.

Table 9. Credits and required biology courses for schools which have specified course and credit requirements.

Category	No. of Schools	Biology Credits		Chemistry Credits		Physics Credits		Math Credits	
AAUP Class									
I	42	33.5±12.4	(90)	10.7±8.3	(66)	5.0±4.3	(62)	4.6±4.1	(67)
IIA	85	36.6±6.3	(100)	11.1±8.9	(67)	4.4±4.2	(54)	3.5±3.7	(52)
IIB	84	34.7±16.5	(98)	6.9±12.5	(45)	2.8±4.0	(33)	2.4±4.0	(37)
Size									
>20K	8	35.4	(88)	15.4	(88)	6.5	(75)	5.3	(75)
>15K<20K	7	37.6	(100)	14.0	(86)	7.1	(86)	5.4	(86)
>10K<15K	27	33.7±8.3	(96)	8.9±8.1	(59)	3.3±4.7	(47)	4.7±4.4	(52)
>5K<10K	39	36.7±9.5	(97)	10.6±7.5	(69)	5.0±4.7	(64)	4.2±3.6	(67)
>3K<5K	34	35.1±8.3	(97)	11.1±8.5	(68)	5.0±4.1	(62)	3.8±4.2	(50)
>2K<3K	20	35.6±5.4	(100)	7.0±10.3	(35)	3.0±4.3	(35)	2.0±3.5	(30)
>1K<2K	55	35.8±8.0	(98)	7.5±9.5	(45)	2.5±4.1	(29)	2.4±3.5	(36)
<1K	34	3.4±9.6	(94)	8.3±8.1	(55)	2.8±3.9	(35)	2.5±3.3	(44)
Rating									
>4.5	16	28.2±14.0	(87)	6.7±7.7	(43)	3.3±4.3	(44)	2.9±4.0	(44)
>4.0<4.5	16	31.7±9.0	(94)	11.0±9.9	(63)	5.3±4.2	(63)	4.4±4.0	(63)
>3.2<4.0	26	37.3±7.9	(88)	11.5±7.7	(73)	5.4±4.0	(69)	4.2±3.7	(65)
>3.2<3.5	36	36.0±6.6	(100)	9.5±8.2	(61)	4.5±4.4	(53)	3.7±4.2	(50)
>3.0<3.2	53	35.7±9.2	(96)	8.3±9.6	(47)	3.0±4.7	(35)	2.8±3.8	(40)
>2.5<3.0	63	35.7±5.5	(100)	8.6±8.7	(57)	3.1±4.1	(38)	2.6±3.2	(44)
<2.5	12	39.2±4.8	(100)	13.8±9.7	(75)	3.4±3.9	(42)	4.3±4.5	(58)
Degree									
BS	18	29.3±13.2	(94)	13.8±9.6	(83)	6.5±3.5	(83)	5.1±4.0	(72)
BA	12	35.3±9.8	(90)	9.2±9.6	(52)	3.6±4.7	(37)	4.1±4.2	(52)
Degree Type									
Biology	199	35.0±8.4	(97)	9.1±8.9	(56)	3.6±4.3	(45)	3.1±3.8	(47)
Zoology	28	38.0±7.1	(100)	10.9±7.6	(71)	4.6±4.1	(57)	4.4±3.9	(64)
Total	227	35.3±8.3	(97)	9.4±8.8	(58)	3.8±4.2	(46)	3.3±3.8	(49)

Table 10. Numbers of semester credits in Biology, Chemistry, Physics and Math for schools arranged by AAUP class, size, rating, degree, degree type, and total. Values are $\bar{X} \pm SD$. Numbers in parentheses are percentage of schools in the category having credit requirements > 0.

Category	No. of Schools	Biology Credits	Chemistry Credits	Physics Credits	Math Credits
AAUP Class					
I	19	39.7±20.7	15.7±10.4	8.1±7.0	7.0±5.5
IIA	16	47.4±14.8	16.1±11.9	8.0±5.7	6.9±6.4
IIB	5	43.6	17.8	7.8	5.8
Size					
>20K	4	36.3	8.5	5.0	5.0
>15K<20K	3	64.3	20.3	9.0	9.7
>10K<15K	8	36.9	22.0	10.3	7.4
>5K<10K	10	46.9±11.2	17.9±9.7	9.4±5.3	6.7±4.5
>3K<5K	7	49.1	16.1	7.7	8.3
>2K<3K	4	35.5	13.5	6	5.8
>1K<2K	3	42.0	6.7	0.0	0.0
<1K	2	35.5	7.5	7.5	2.5
Rating					
>4.5	10	39.5±14.1	17.8±9.7	9.6±5.3	9.2±5.6
>4.0<4.5	5	29.4	10.2	4.8	4.0
>3.2<4.0	11	48.5±15.8	16.4±11.2	7.9±5.0	4.8±3.9
>3.2<3.5	3	49.7	23.0	9.7	9.0
>3.0<3.2	6	45.8	16.8	8.5	8.8
>2.5<3.0	5	48.4	14.6	6.6	5.2
<2.5	2	37	0.0	0.0	0.0
Degree					
BS	6	27.5	14.5	6.5	5.8
BA	7	34.6	15.0	7.7	4.6
Degree Type					
Biology	31	43.7±16.5	16.0±11.8	7.9±6.1	6.5±6.5
Zoology	12	42.1±18.4	15.1±10.2	7.0±5.2	6.2±4.8
Total	43	43.3±17.1	15.7±11.4	7.6±5.9	6.4±6.1

Table 11. Number of quarter credits in Biology, Chemistry, Physics, and Math for schools arranged by AAUP class, size, rating, degree, degree type, and total. Values are $\bar{X} \pm$ SD. SD is not shown for n < 10.

AAUP Category	No. of Schools	Biology Credits	Chem Credits	Physics Credits	Math Credits
I	42	37.0 (38)	16.0 (28)	8.1 (26)	7.0 (28)
IIA	85	36.6 (85)	16.5 (57)	6.5 (57)	6.7 (45)
IIB	84	35.5 (82)	15.3 (38)	8.3 (28)	6.6 (31)

Values are $\bar{x}$, numbers in parenthesis are numbers of schools having requirement > 0

Table 12. Numbers of required semester credits in Biology, Chemistry, Physics, and Math arranged by AAUP category, for schools having requirements > 0. Values are $\bar{X}$. Numbers in parentheses are number of schools having requirements > 0.

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Executive Summary

Rational Curricular Review for College Biology Departments

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It's a short lane that has no turning.

Samuel Richardson: Clarissa Harlowe

To understand why this project took the strange turn it did, it is necessary to go back to a few years before the application for a grant from FIPSE was made. The Department of Zoology at the University of Rhode Island had just received a new chairman. As part of his efforts to revitalize the department, he wanted a curriculum review, and toward that end, apponted a curriculum committee. That fateful step initiated a chain of events in which Lewis Carroll would have taken great delight.

Because this story involves living personalities, in order to protect the good name, career, and body parts of the principals, chief among them this Project Director, certain events, circumstances, and sequences will be changed, but the thrust of the story, and the lessons to be learned, will emerge intact. To continue now--.

As the curriculum committee began its debates, it quickly became apparent that debate was destined to be the primary force shaping the curriculum. It seemed evident to some members of the department that a better curriculum would emerge if we could generate some data--retrospective surveys of alumni, interviews with students, interviews with experts in curriculum design, needs of employers and grad schools, etc. All of this would require time and resources that the department didn't have.

The curriculum committee had been discussing, arguing, persuading, and negotiating for about a year, when some members of the department heard about FIPSE and its grants. Here seemed to be an answer to our dilemma--FIPSE could provide us with the resources to develop a rational, data-driven curriculum, so that we wouldn't have to argue about things any more--we could let the facts guide our decisions. That seemed to be the scientific thing to do, and entirely appropriate to a science department. It should be evident that those of us who at that time had this incredibly näive idea had never taken a political science

course. It never occured to us that there might be individuals in the department who might not want facts. As the lawyers have taken as dogma for years; if the law is on your side, ignore the facts and argue the law. If the facts are on your side, forget the law, and argue the facts.

Se we blithly went ahead and applied for FIPSE support. There was no opposition in the department, because it would have been embarassing to oppose something that purported to lead us to a better curriculum. Since the odds of getting a FIPSE proposal approved were so long, the proposal didn't represent a significant threat to the rhetoriticians.

Then, lo and behold, the FIPSE proposal was approved. By the time it went on-line, the curriculum committee was well on its way to having blocked out a rhetoric-based curriculum. The ugly spectre was created of FIPSE--supported work generating hard information that might force a conclusion different than that established by argument and internal politics. The opportunity for the FIPSE grant to create friction within the department became evident at the first FIPSE sponsored activity.

The chairman of the department, not wishing to generate sinusoidal movements (I normally would have said "make waves", but this is supposed to be a Federal report), appointed a new "FIPSE committee', to be headed by the FIPSE project director, to act in an advisory capacity to the "real" curriculum committee. As Lord Chesterfield said, "Advice is seldom welcome; and those who want it the most always like it the least." A more cumbersome administrative arrangement could scarcely be imagined, especially in a department which had well developed factions, as is the case with many academic departments. In the particular instance, the chair of the curriculum committee was in one faction, the chair of the FIPSE committee in another. Instantly, "advice" from the FIPSE committee was interpreted as "criticism" by the curriculum committee.

The FIPSE committee's first step was to sponsor an all day faculty retreat, which featured participation by a nationally recognized expert in curriculum design. Our consultant was Dr. Robert Diamond, of Syrcause University. We essentially asked Dr. Diamond, "How should you design a curriculum?" We described our situation to him, and his ideas were marvelous. Had we been able to incorporate his suggestions, which are outlined in Appendix 1, we would have been able to meet the objectives of the original FIPSE proposal in every respect. If one piece of advise has emerged from this project, it is, "Hire a first-class curriculum consultant, then do what he says." Almost everything that he said could go wrong in the design of curriculum did go wrong, in eerily prescient fashion. The fact that the chairman of the curriculum committee, and all of its members but one did not attend the workshop was an ominous sign.

At first, the FIPSE committee busily started out to follow Diamond's suggestions. We profiled the backgrounds of entering freshmen. Diamond had suggested that all affected parties to a curriculum around campus should be invited to participate in the development process at the earliest stage, so we did an elaborate search amongst all courses in the university to see which had Zoology prerequisites. We discovered that 18 departments had one or more of our courses as prerequisites, and thus could be expected to be very interested in any new Zoology curriculum. We circulated a questionnaire amongst our own faculty to determine what they thought the objectives of a good curriculum should be. Many of these procedures required a good deal of faculty and support staff time to gather and interpret.

It soon became evident that the "advice" being passed to the curriculum committee from FIPSE was not being used in their discussions. "Ignored" might be too strong a word, but it seemed clear that the role of information provided by the FIPSE committee was indeed subtle.

After the first year of the project, the FIPSE committee had to face the fact that for our department, any further effort expended in gathering information for the development of curriculum in our department was an exercise in futility. We could have turned in the balance of the FIPSE grant, but that would have been horribly embarrassing for all concerned. If we kept it, however, what would be an ethical thing to concentrate on, that would still be within the general outline of the original proposal?

As Benjamin Franklin said, "Diligence is the mother of good luck," and that was certainly true in this situation. In the first year of the project, we had sent questionnaires to over 600 American college biology departments, asking then to supply us with their course requirements. As the results came in, it swiftly became evident that this information would be of intense interest, not only to academic departments, but text publishers, and the people who make up standardized post-graduation exams, like the GRE's. For the first time, we had an idea about what courses American biology graduates might be expected to have upon graduation.

We spent most of the greatly reduced effort in the second year (a good bit of the money requested for the second year was in fact left over) refining this study. It has been accepted for publication in BIOSCIENCE, the most widely read general biology publication in the U.S., (Appendix 2) and an expanded version is being included in the report of the Task Force on Biology of the American Association of Colleges, to be presented at their annual meeting in San Francisco in January.

Two conclusions have clearly jumped out of this study:

1. For departments. As soon as you have decided to look at your curriculum, hire a first-rate consultant on curriculum design. Your department might contain the world's formost biologists, but you are rank amateurs at curriculum design, which includes considerations far beyond the mere contents of courses.

2. For individual faculty. If you value your friendships and your sanity, avoid service on curriculum committees at all cost.

Experience is the name everyone gives to their mistakes.

Oscar Wilde, Lady Windermere's Fan

This project was both a crashing failure, and a stunning success. Almost none of the original objectives were attained, but one of the incidental sub-projects has already turned out to have a national audience, and will almost certainly have a far-reaching national impact.

The original premise of the proposal was that college curriculum development can be thought of as a rational process, therefore there ought to be a rational, data-based, and systematic way of going about it, free of politics and emotional concerns. We asked for support to develop such a process of rational curriculum development, then use it to help our department, the Department of Zoology at the University of Rhode Island, develop a carefully thought out, data-based curriculum. As it turned out, this was an extraordinarily näive premise.

Because the story of why our department took the path it did might well serve as a cautionary tale for other college departments considering curricular change, that tale will be told. Because I must continue to live and work with my colleagues, and have no desire to change my route home every evening, certain events and circumstances must be changed, but the essence of things will emerge. Some aspects of our situation are probably unique, but I suspect that many elements that contributed to our peculiar scenario are generalizable.

Because many people never get beyond the first few pages of a government report I will somewhat interrupt the narrative flow to warn: Departments! If you are thinking about changing your curriculum--think twice! We spent over 1,000 person-hours in wrangling, bickering, forming and breaking alliances, negotiating, swapping, and propagating and spreading rumors. Very few of those hours were spent on data-generated development of curriculum, and the preliminary signs are that our new curriculum is worse than our old one.

Our story begins a few years back, when we acquired a new chairman, after having had a single chairman for about a dozen years. As part of the New Era, the chair decided to form a committee to see if a new curriculum was needed. There was no particular feeling that there was anything drastically wrong with the old curriculum, but the New Broom wanted the curriculum on the table, along with committee structure, and other housekeeping functions of the department.

The chairman had walked into a department that was factionalized, as are many college departments. In our case, there were two, loose groups rather neatly bisecting the department, accompanied by a few renegades and mavericks who were essentially unclassifiable. To be equally unflattering to both factions, I shall call them the Moles and the Slugs. Fortunately, personal relationships between the Moles and the Slugs were generally neutral to good; there were no bitter, non-speaking enemies. The Moles and Slugs were mildly, and vaguely contemptuous of each other from a professional

standpoint, each feeling that the other group was less productive, and less--relevant. Had the Moles and Slugs been working on collaborative projects, this might have resulted in a healthly team competition, but the only thing both the Moles and Slugs had in common was their distaste for non-Moles, and non-Slugs, respectively. Neither the department as a whole, nor the Moles and Slugs ever had had much luck in doing anything collectively. Ayn Rand would have loved our department.

Although the department chairman was a Mole, he appointed a Slug to be chair of the new curriculum committee, normally a wise political move in an equally-factionated department. The other members of the committee were about equally divided between Moles and Slugs.

The initial deliberations of the committee revolved around what changes were needed to have a more "Modern" (read Slug-like) curriculum. This was a clever approach for the committee chair, because to then argue for more Mole courses was to argue for retrogression and living in the past.

The original committee deliberations were almost entirely based on rhetoric. The committee gathered little if any data, conducted no surveys among students or alumni, consulted with no curriculum experts. The committee had found out what attornies long ago discovered; facts only serve to confuse juries, and ideally, are to be dispensed with altogether. Significant numbers of both the Moles and Slugs argued that data-gathering was not necessary; as experts in Zoology, we were in a better position than anyone to know what was required for students to be

contemporary in biology today. The fact that we had no idea where our students went after graduation, how well they did (with the exception of the well-known success stories, who we paraded in our recruiting literature), or what they, employees, or grad students thought of our curriculum was considered irrelevant, if the object was to develop a strong curriculum in Modern Biology.

The deliberations of this committee proceeded at an excruciatingly slow pace. That is, until the Evil Legislators did their infamous audit. A committee of the Rhode Island legislature commissioned an audit of the teaching loads at the University. Surprise! They discovered that teaching loads at the University were less than those at the Community College. The legislature, in its wisdom, then said, "You people down there are going to have to shape up!" In a rare display of administrative courage, the University then said "Yes, Boss. Right away, Sir!"

The upshot was a new series of regulations that stated minimum teaching expectations for <u>each faculty member</u> (not a minimum departmental average), and minimum class sizes for each level of class. Thus, if you had fewer than eight students in your graduate course, you were more than welcome to teach it, and thank you very much, but it couldn't be counted as part of your teaching expectation. Instantly, the old departmental stabilities disappeared, where those who liked to teach big classes and were good at it tended to teach relatively more, and research-oriented people who were best allowed never to come close to a classroom, taught relatively less.

Overnight, the whole curriculum question gained a new perspective. Instructors who taught five or six low-enrollment courses a year, found that due to minimum class size regulations, they now had no official teaching load, according to the books. The kindly front office let it be known that departments which did not have themselves fully loaded up, according to the new regulations, could kiss sabbatical or retirement replacements goodbye. Both the Moles and Slugs could see that students had to be gotten into classes pronto, and those "golden" classes which met minimum enrollment had to be distributed amongst the faculty, or the department would very quickly become an ex-department.

Many departments quickly discovered a loophole in the system. Quite properly, the teaching of a large class was considered to be more time-demanding than a small one, so any class with more than 100 students was counted as two courses. Departments, like the Department of Truth and Beauty, which and many very large courses (say 3-500 students) which were usually taught by people who had some expertise and liking for large classes, instantly divided them into sections with slightly more than 100 students, and assigned them to people who previously had taught only upper division or grad courses. In this way, by receiving double credit, the course-deficient prof could satisfy the regulations. The effect on teaching quality can be imagined. Some professors were quick to exploit the system, dropping two or three low enrollment upper division courses, and swapping them for one section of a big course.

In our department, the impact of the regulations was not felt equally by the Moles and the Slugs. For a variety of reasons, Slug courses tended to have low enrollments, and under the old curriculum, Slugs might well become an endangered species.

Naturally, this topic was never discussed in open meeting, nor was anything put on paper (making this chronicler's task much more difficult). Backstage, and off the record, it was Topic No. 1.

It was against this backdrop that I brashly suggested that we could all save ourselves time and trouble by approaching curriculum development in a logical fashion--after all, we were all scientists--and maybe FIPSE could help us by giving us the resources to develop a truly logical, data-based curriculum. It should be evident by now that perception of the nuances of department politics was not then one of my strong points.

The chairman approved the proposal--but how could he refuse, when the administration was putting tremendous pressure on departments to generate more grant proposals? The dean was delighted--a FIPSE grant is a high prestige item in many quarters. The Slug who headed the curriculum committee couldn't very well object to a possibility of help with her work. I suspect now that the situation was very much like the plot of the old Mel Brooks movie, "The Producers", where Zero Mostel vastly oversold subscriptions to a new musical, knowing that when it flopped, he would reap a huge profit from the oversubscription. Imagine his horror when the musical, "Springtime for Hitler"

turned out to be a raging success, and all the subscribers started demanding their share of the profits. Imagine the horror of those affected when the FIPSE proposal, against comfortably impossible odds, was actually approved.

The department's problem was that by the time the FIPSE curriculum proposal was approved, the Slug-dominated curriculum committee had already blocked out a new curriculum that would be "modern" (hence unassailable), and coincidentally go a long way toward eliminating the Slugs' low enrollment problems. The Moles rumbled and grumbled about this, but the Slugs' gain in this case would not really come at the expense of the Moles,--so most of the Moles' objections were departmental ones--the new curriculum is too inflexible, it's unattractive to uncommitted freshmen, 1st year students won't be able to handle the first semester core course without a survey course first, etc.

The department chairman's problem was that he had a sitting curriculum committee, and now a fat curriculum grant whose project director was not even on the selfsame committee. Clearly, he could not displace the existing committee chairman, or the Slugs would get <u>really</u> slimy. He did probably the only thing possible. He created a FIPSE commiteee which would have an advisory function to the curriculum committee. Naturally, as PD, I would be the chair of the FIPSE committee. As I was a Mole, this was about like hiring Daniel Ellsberg to be National Security Adviser to Lyndon Johnson.

Unfortunately, and probably unavoidably, the FIPSE committe came to be perceived as a Mole plot to undermine the new curriculum, despite the fact that the FIPSE committee had some outspoken Slugs in its makeup.

It quickly became obvious that the FIPSE committee was going to generate much good information that would be graciously received, and would then vanish into the ether. For example, at the outset of the grant period, at great expense, we brought in one of the leading gurus of college curriculum development, and sponsored a weekend retreat at the University's conference center. All who attended agreed that it was a marvelous, and enormously profitable experience, but rather pointedly, the chair of the curriculum committee had other obligations, as did all but one of the other members of the curriculum committee.

Although our guru had suggested that it was not a good idea to try to patch up a curriculum, but rather to start from scratch once it was decided what you wanted to do with the curriculum, the FIPSE committee decided that it would be nice to ask the question, "What, if anything, is wrong with the old curriculum?"

It quickly became evident that our products, the Zoology majors, were by and large doing very well for themselves. Those going to grad school reported back that their undergrad preparation served them well, GRE and MCAT scores were good for the pre-meds and pre-professionals, and our grads seemd to compete well in the employment market. To be sure, there were retrospective complaints about individual teachers, but very few systemic complaints about the Zoology curriculum.

There were, however, many vitriolic comments about a sequence of required courses taught outside the department: we'll call them Grindingly Difficult I and Grindingly Difficult II. Both were killer courses, and in the case of Grindingly II, the flunk rate was over 50%--and this was for sophomore and junior students.

By interviewing students who had initially declared themselves to be Zoology majors, and then changed, we found that Grindingly II was having a pernicious effect on our program. Students were changing their majors to avoid the necessity of Grindingly II. Where were they going? To the Department of Animal Love.

Animal Love was a relict department in another college that had been losing students for years, and was fighting for survival. They discovered that that they could offer a relatively easy degree in Animal Love as an alternate to pre-professional Zoology students frightened off by Grindingly II. A kind of academic Gresham's Law was starting to operate, where students were moving away from the more difficult, worthwhile degree, to a less demanding, low-prestige degree where they could earn a higher grade point. Clearly, Grindingly II was hurting us, and hurting badly, as the overall number of science students, both locally and nationally, declined. Even without the new minimum enrollment directives, Grindingly II needed a long, hard look.

Unfortunately, discussions about the wisdom of continuing to require Grindingly II because it was killing our program quickly mutated to the general, and eternal debate over whether Rigor truly equals Godliness. Sadly, we were unable to resovlve this question for the benefit of future generations of academics.

While the curriculum committee was inexorably marching toward a New Curriculum, the FIPSE committee was busily trying to determine first, what a good curriculum was, second, what a curriculum was supposed to do, and third, how to go about getting a curriculum to do what you wanted it to do. Toward these ends, the FIPSE committee thought it might be useful to see what other biology and zoology departments had for curricula. Maybe we could see if there were any particularly innovative ones, from which we could steal ideas. We hired a couple of grad students to set up a data base program for us, then sent out hundreds of letters to different schools, asking their department chairs to share their curricula with us.

This effort, which was started mostly as a kind of afterthought, "what if" sort of thing, developed into something that was the most worthwhile part of this whole project. We discovered that there is what amounts to a "Standard" curriculum among biology and zoology departments in the United States. There are tiny numbers of "innovative" curricula in biology, primarily found in smaller schools. There were no clear-cut patterns of difference in the curricula of highly-rated, and low-rated schools, although high ranked schools tended to have greater physical science requirements.

The finished study, which is included here as Appendix 2, has been accepted for publication in BIOSCIENCE, the leading biological science journal, and an expanded version is being incorporated into the report of the Task Force in Biology of the American Association of Colleges. The audience for the study is thus going to be vastly larger than anything we imagined at the outset.

When it became clear that studies specifically aimed at assisting our department to have a data-based curriculum were going to be politely received, then vanish withou a trace, the FIPSE committee cut back on many activities that had been outlined in the original proposal---for this reason, we are turning money back to FIPSE, for which we apologize. Evidently it is normally considered somewhat sinful to spend less than the amount allocated in a federal grant. It seemed pointless to visit schools with innovative curricula when, A. those schools were so different from ours, that their solutions simply couldn't work in our case, and B. the curriculum committee was already locked into a particular pathway.

Every good story has a little twist at the end, and so does this one. After all was said and done, we had a New Curriculum, and the first students are taking the first course in the new core curriculum as this is being written. It is much too early to tell, but students are flunking the first course in the core at about twice the rate they did in the old freshman survey course. Since the only logically derivable difficulty of the old curriculum was that some parts of it were too tough, and students

were being driven away, the New Curriculum is not off to a stellar beginning.

The wonderful thing, however is that for us, it doesn't really matter! The biological sciences at the University of Rhode Island are currently being reorganized and scrambled. In two years or so, there will be brand new departments, Zoology will vanish, and WE WILL GET TO DO IT ALL OVER AGAIN!

As my colleagues face this grim prospect (I, regretfully, am planning to be doing field research on Bora-Bora when the new curriculum committee is formed), what lessons might they learn from our experience?

1. Forming a new curriculum is wildly expensive in terms of faculty effort. Be prepared, and double your worst case estimate for the amount of time involved.

2. The collective intelligence of a department can be less than the average intelligence of its members.

3. When the button finally gets pushed, logic, reasoning, and rationality have relatively little to do with curriculum design. Power, turf, and survival are vastly more significant.

4. Good, motivated teachers in well equipped classrooms, with a supportive administration are far more important to a good biology education than any particular curriculum design.

5. Logic is no match for rhetoric.

6. If there are factions in a department, setting up a new curriculum is likely to magnify the differences, and create wonderful new opportunities for bad blood.

7. In a biology department, where many of the majors are destined for professional or grad schools, there is little room for radical experimentation, given the realities of pre-professional standardized exams, especially in large schools.

8. When it comes down to survival, there is no such thing as an altruistic department.

9. As the great Greek philosopher Thales once said, "What is difficult? To know ones' self. What is easy? To advise others."

My conclusion after all this? I need look no further than the sage old Yankee observation:

If it ain't broke, don't fix it.

FIPSE Information

It was basically a pleasure doing business with FIPSE. Contrary to other dealings I've had with Feds, FIPSE Washington people seemd to know what they were doing, didn't involve PD's with internal problems (if they existed), and kept out of PD's hair. The annual meetings might have been improved a bit by having some kind of indexed project descriptions in the hands of PDs at an earlier state (this was done at the '87 meeting, I believe).

There were initial problems dealing with the awards being announced so close to the beginning of the academic year. By the time the semester starts, qualified grad students already have jobs, and we lost a lot of time trying to find a student qualified in computers.

Overall, the complaints are small, and mentioned only because if I gave unqualified praise it wouldn't have credibility--nothing is perfect.

The idea of an agency willing and able to gamble on odd projects is great.